

**CONTINENTAL MARGIN OF  
EASTERN CANADA**

**GEOCHEMISTRY AND EXPLORATION  
SIGNIFICANCE OF CRUDE OILS  
FROM THE EASTERN CANADIAN SHELF**

**GEO****MARK  
RESEARCH, INC.**

**PROSPECTUS**

# GEOCHEMISTRY AND EXPLORATION SIGNIFICANCE OF CRUDE OILS FROM THE EASTERN CANADIAN SHELF

## Introduction

GEOMARK RESEARCH, INC. has completed a detailed investigation of the geochemistry of crude oils and “condensates from the eastern continental shelf of Canada. **Figure 1** shows the project area that includes the Labrador Shelf (Saglek and Hopedale basins), Newfoundland Shelf/Grand Banks area (East Newfoundland and Jeanne d’Arc basins), and the offshore Nova Scotian Shelf (Scotian Basin).

The study focuses on basins formed during Triassic-Jurassic and Cretaceous rifting. In many of these basins, Triassic-Jurassic evaporites overlie redbed sequences. The evaporites are overlain by Jurassic, Cretaceous, and Tertiary clastics and carbonates. The most important reservoirs are provided by Jurassic and Cretaceous section (Scotian Basin and Grand Banks), and Cretaceous clastics (Labrador Shelf). Sources are Jurassic and Cretaceous in age. One or more Jurassic intervals are the source(s) for the moderate to high gravity, low sulfur oils at Hibernia Field (Jeanne d’Arc Basin -- Chang, 1998 and Mackay and Tankard, 1990). The giant Hibernia Field accumulation and accumulations in the Sable Island and Venture areas of the Scotian Basin are clearly “key” to interpreting the relative geochemical complexity of this important developing petroleum province.

## Oil Geochemistry

This study involved the analysis of 122 oils and from the eastern Canadian shelf, 41 samples from the Atlantic continental margin of Great Britain (Pocupine Basin and West of Shetlands area), and a single sample from the Baltimore Canyon (offshore New Jersey). The non-Canadian samples are added to contrast and compare the chemistry of similar age sources on opposing margins of the proto-Atlantic Ocean. Samples that are being analyzed for the project are identified in **Table 1**.

GEOMARK has previously demonstrated the interpretative importance of large numbers of oil samples in regional studies (for example, studies in the greater Gulf of Mexico Basin – Zumberge *et al.*, 1997). Oil geochemistry provides a basis for efficiently estimating limits of petroleum systems. Differences in crude oil composition, sometimes dismissed as normal compositional variations, are often sufficient to establish existence of multiple sources, source facies, oil mixing, multiple source depocenters, and under-explored systems.



Figure 1. Map showing location of samples analyzed for this study.

Each oil was characterized by an analytical program that included bulk compositional data, quantitative analysis of aromatic and saturate (terpanes and steranes) biomarkers, and determinations of stable isotope compositions of the saturate and aromatic hydrocarbon fractions. Rigorous comparison and classification of geochemical data was accomplished using cluster and principal component analyses (Moldowan *et al.*, 1985 and Zumberge, 1987).

A special effort was made to compare thermal maturities of the oils and condensates. Knowledge of the distribution of relative maturities of oils derived from a common source can provide useful information. A range of maturities within a “small” area may indicate multiple and separate source depocenters for the oils, or complex migration and accumulation histories. It is informative to determine if maturities as suggested by API gravities (for example) are a product of thermal maturation, migration-fractionation, bacterial degradation, or a combination of processes. Maturities will be estimated using C<sub>15+</sub> biomarker techniques (Peters and Moldowan, 1993) and, where practical, gasoline range hydrocarbons.

## Presentation

Data from the project are organized in an *interpretative volume* and into several *data volumes*. The *interpretative volume* contains discussions of the regional geologic setting of the oils, discussions of the oil geochemistry, and an integrated interpretation of the significance of the oils. Analytical data for the oils are provided in hardcopy *data volumes* and digitally. The digital data are presented in a database constructed using Access<sup>TM</sup> and can be displayed using ArcView<sup>TM</sup> geographic information system (GIS). The oil data include the following.

- Physical property data (API gravity, % Sulfur, Ni/V ratios)
- C<sub>15+</sub> fraction versus <C<sub>15+</sub> fraction
- Deasphalting
- Liquid chromatography (% Saturates, % Aromatics, and % NSO's)
- Capillary gas chromatography of whole crude oil
- Capillary gas chromatography of gasoline range hydrocarbons (selected samples)
- Stable carbon isotopic composition of C<sub>15+</sub> saturate and aromatic hydrocarbons
- Compound specific isotope analyses on gasoline range hydrocarbons (selected samples)
- Quantitative GC/MS analysis of C<sub>15+</sub> saturate hydrocarbons for terpane and sterane distributions
- GC/MS of aromatic hydrocarbon fraction

## **Participation**

The complete study is available at a cost of US \$ 37,500.00.

## **Timing**

The report is completed and available for delivery.

## **For Additional Information Contact:**

**Mr. Stephen W. Brown**  
**GEOMARK RESEARCH, INC.**  
**9748 Whithorn Drive**  
**Houston, Texas 77095**  
**USA**  
**Telephone: (281) 856-9333**  
**Fax: (281) 856-2987**  
**E-mail: [sbrown@geomarkresearch.com](mailto:sbrown@geomarkresearch.com)**

## **References**

Chang, Thi, 1998, Canada's Hibernia crude assayed: *Oil and Gas Journal*, October 26, 1998, p. 86-87.

Mackay, A.H. and A.J. Tankard, 1990, Hibernia oil field – Canada, Jeanne d'Arc Basin, Grand Banks offshore Newfoundland: Structural Traps III, Tectonic Fold and Fault Traps, *Treatise of Petroleum Geology, Atlas of Oil and Gas Fields*, p. 145-175.

Moldowan, J.M., W.K. Seifert, and E.J. Gallegos, 1985, Relationship between petroleum composition and depositional environment of source rocks: *Geochimica et Cosmochimica Acta*, v. 54, p. 1315-1268.

Peters, K.E. and J.M. Moldowan, 1993, *The Biomarker Guide*: Prentice Hall, Englewood Cliffs, New Jersey, 363 p.

Zumberge, J.E., 1987, Prediction of source rock characteristics based on terpane biomarkers in crude oils: A multivariate statistical approach: *Geochimica et Cosmochimica Acta*, v. 51, p. 1625-1637.

Zumberge, J.E., H.A. Illich, J. Pratsch, S.W. Brown, and C.F. Schiefelbein, 1997, Gulf of Mexico oil study, Part III, the petroleum geochemistry of the offshore Gulf of Mexico: a proprietary report prepared for project participants, interpretive volume 180 p.

**Table 1**  
**Samples analyzed in the Eastern Canadian Oil Study**

Country	Region / Basin	Field	Well	Depth
Eastern Canada	Nova Scotia	Alma	F-67	2911-2917m
Eastern Canada	Nova Scotia	Alma	F-67	
Eastern Canada	Nova Scotia	Glenelg	E-58	3567-3578m
Eastern Canada	Nova Scotia	Glenelg	J-48	3491-3495.5m
Eastern Canada	Nova Scotia	Glenelg	N-49	3390.5-3401.5m
Eastern Canada	Nova Scotia	Alma	K-85	3476-3485m
Eastern Canada	Nova Scotia	Chebucto	K-90	
Eastern Canada	Nova Scotia	North Triumph	G-43	3795-3809m
Eastern Canada	Nova Scotia	Panuke	PP1 I-99	2901.5-2905.5m
Eastern Canada	Nova Scotia	Panuke	B-90	
Eastern Canada	Nova Scotia	Intrepid	L-80	1645' (?)
Eastern Canada	Nova Scotia	Intrepid	L-80	11100-11120'
Eastern Canada	Nova Scotia	Cohasset	CP6B P-51	2148.8-2153.8m
Eastern Canada	Nova Scotia	Cohasset	CP3A P-51	4532.5-4536m
Eastern Canada	Nova Scotia	Cohasset	CP9 P-51	2125-2129.5m
Eastern Canada	Nova Scotia	Cohasset	CP4 P-51	2060-2064.5m
Eastern Canada	Nova Scotia	Cohasset	D-42	
Eastern Canada	Nova Scotia	Cohasset	D-42	
Eastern Canada	Nova Scotia	Cohasset	A-52	
Eastern Canada	Nova Scotia	Cohasset	A-52	
Eastern Canada	Nova Scotia	Balmoral	M-32	2065-2068m
Eastern Canada	Nova Scotia	Thebaud	I-93	3912-3919.5m
Eastern Canada	Nova Scotia	Thebaud	C-74	3914-3930m
Eastern Canada	Nova Scotia	Thebaud	C-74	4748-4761m
Eastern Canada	Nova Scotia	South Sable	B-44	11948-11968'
Eastern Canada	Nova Scotia	Thebaud	I-94	
Eastern Canada	Nova Scotia	Thebaud	P-84	10542-10552'
Eastern Canada	Nova Scotia	Thebaud	P-84	11038-11050'
Eastern Canada	Nova Scotia	Sable Island	E-48	
Eastern Canada	Nova Scotia	Sable Island	E-48	4790-4795m
Eastern Canada	Nova Scotia	Sable Island	1-H-58	
Eastern Canada	Nova Scotia	Sable Island	2-H-58	5115-5142'
Eastern Canada	Nova Scotia	Sable Island	2-H-58	6267-6280'
Eastern Canada	Nova Scotia	Sable Island	5-H-58	
Eastern Canada	Nova Scotia	Sable Island	5-H-58	
Eastern Canada	Nova Scotia	Sable Island	3-H-58	5407-5411'
Eastern Canada	Nova Scotia	South Venture	O-59	3926-3932m
Eastern Canada	Nova Scotia	South Venture	O-59	5035-5050m
Eastern Canada	Nova Scotia	Primrose	N-50	4916-5026'
Eastern Canada	Nova Scotia	Primrose	N-50	Wyandot
Eastern Canada	Nova Scotia	Primrose	A-41	4960-5020'
Eastern Canada	Nova Scotia	Olympia	O-51	4356-4386m
Eastern Canada	Nova Scotia	West Venture	C-62	4741-4743m
Eastern Canada	Nova Scotia	Olympia	A-12	4622-4633m
Eastern Canada	Nova Scotia	Venture	B-52	15456-15509'
Eastern Canada	Nova Scotia	Venture	B-52	17338-17365'
Eastern Canada	Nova Scotia	Venture	H-22	4975-4983m
Eastern Canada	Nova Scotia	Venture	H-22	16473-16486'
Eastern Canada	Nova Scotia	Heron	H-73	7525-7565'
Eastern Canada	Nova Scotia	Venture	B-43	15354-15387'
Eastern Canada	Nova Scotia	Venture	B-43	17974-18028'
Eastern Canada	Nova Scotia	Venture	B-43	16020-16047'

Country	Region / Basin	Field	Well	Depth
Eastern Canada	Nova Scotia	Venture	D-23	4711m
Eastern Canada	Nova Scotia	Arcadia	J-16	5165-5175m
Eastern Canada	Nova Scotia	Bluenose	2-G-47	4577-4590m
Eastern Canada	Nova Scotia	Citnalta	I-59	
Eastern Canada	Nova Scotia	Penobscot	L-30	8659'
Eastern Canada	Nova Scotia	Banquereru	C-21	3585-3596m
Eastern Canada	Nova Scotia	Uniacke	G-72	
Eastern Canada	Newfoundland	Beothuk	M-05	10029-10042'
Eastern Canada	Newfoundland	kings Cove	A-26	1540-1560m
Eastern Canada	Newfoundland	Terra Nova	I-97	3303.5-3335m
Eastern Canada	Newfoundland	Terra Nova	K-07	3328.5-3337m
Eastern Canada	Newfoundland	Terra Nova	K-08	3329-3336m
Eastern Canada	Newfoundland	Terra Nova	K-08	3530-3543.5m
Eastern Canada	Newfoundland	Terra Nova	C-09	3438-3486m
Eastern Canada	Newfoundland	Terra Nova	E-79	3331-3340m
Eastern Canada	Newfoundland	Terra Nova	E-79	3223-3242m
Eastern Canada	Newfoundland	Terra Nova	H-99	3224-3234m
Eastern Canada	Newfoundland	Hebron	I-13	6251-6284'
Eastern Canada	Newfoundland	Hebron	I-13	2974.8-2985.8m
Eastern Canada	Newfoundland	Hebron	I-13	3842-3857m
Eastern Canada	Newfoundland	Hebron	I-13	4368-4381m
Eastern Canada	Newfoundland	West Ben Nevis	B-75	2445-2465m
Eastern Canada	Newfoundland	Ben Nevis	I-45	2420.1-2432m
Eastern Canada	Newfoundland	Ben Nevis	I-45	4426.1-4437.9m
Eastern Canada	Newfoundland	Fortune	G-57	12438-14608'
Eastern Canada	Newfoundland	Fortune	G-57	4032-4039m
Eastern Canada	Newfoundland	South Mara	C-13	9685-9705'
Eastern Canada	Newfoundland	North Ben Nevis	P-93	3090-3095m
Eastern Canada	Newfoundland	Hibernia	J-34	2481-2498m
Eastern Canada	Newfoundland	Hibernia	J-34	2595-2609m
Eastern Canada	Newfoundland	Hibernia	K-14	2344-2371m
Eastern Canada	Newfoundland	Hibernia	K-14	3933-3945m
Eastern Canada	Newfoundland	Mara	M-54	1851.5-1857m
Eastern Canada	Newfoundland	Hibernia	O-35	2055-2066m
Eastern Canada	Newfoundland	Hibernia	O-35	2536.9-2548.2m
Eastern Canada	Newfoundland	Hibernia	P-15	2422-2443m
Eastern Canada	Newfoundland	Hibernia	P-15	3805-3822m
Eastern Canada	Newfoundland	Hibernia	P-15	4113-4134
Eastern Canada	Newfoundland	Hibernia	C-96	12609-12645'
Eastern Canada	Newfoundland	Hibernia	C-96	3940-3946m
Eastern Canada	Newfoundland	Hibernia	I-46	2387-2405m
Eastern Canada	Newfoundland	Hibernia	I-46	2599-2602m
Eastern Canada	Newfoundland	Hibernia	B-27	2550-2561m
Eastern Canada	Newfoundland	Hibernia	B-27	3953-3960m
Eastern Canada	Newfoundland	Hibernia	B-08	2648-2661m
Eastern Canada	Newfoundland	Hibernia	B-08	3018-3033m
Eastern Canada	Newfoundland	Hibernia	B-08	11582-11631'
Eastern Canada	Newfoundland	Hibernia	B-08	11750-11781'
Eastern Canada	Newfoundland	Hibernia	B-08	3705.2-3714.9m
Eastern Canada	Newfoundland	Hibernia	K-18	2285-2294m
Eastern Canada	Newfoundland	Hibernia	K-18	3210-3217m
Eastern Canada	Newfoundland	Hibernia	K-18	3850-3859m
Eastern Canada	Newfoundland	Whiterose	J-49	3212-3218.5m
Eastern Canada	Newfoundland	Whiterose	L-61	2527.5-2534m
Eastern Canada	Newfoundland	Nautilus	C-92	10908-10944'
Eastern Canada	Newfoundland	Whiterose	N-22	2664-2681m
Eastern Canada	Newfoundland	Whiterose	N-22	3565-3572m

Country	Region / Basin	Field	Well	Depth
Eastern Canada	Newfoundland	Trave	E-87	2144-2150.1m
Eastern Canada	Newfoundland	Trave	E-87	2232.1-2237.6m
Eastern Canada	Newfoundland	Adolphus	2K-41	8560-8685'
Eastern Canada	Newfoundland	South Tempest	G-88	3826-3838m
Eastern Canada	Newfoundland	South Tempest	G-88	4041-4048.9m
Eastern Canada	Newfoundland	South Tempest	G-88	4109-4116.9m
Eastern Canada	Newfoundland	North Dana	I-43	14885-14921'
Eastern Canada	Newfoundland	Gudrid	H-55	8738-8934'
Eastern Canada	Newfoundland	Bjarni	O-82	2362-2373m
Eastern Canada	Newfoundland	Hopedale	E-33	1938-1997m
Eastern Canada	Newfoundland	Snorri	J-90	Not Given
Eastern Canada	Newfoundland	Thorvald	P-24	3122.5m
Ireland	Porcupine	26	28-1	2328
Ireland	Porcupine	26	28-1	2245
Ireland	Porcupine	26	28-1	597
Ireland	Porcupine	26	28-2	
Ireland	Porcupine	26	28-2	
Ireland	Porcupine	26	28-2	
Ireland	Porcupine	26	28-1	2247
Ireland	Porcupine	35	8-1	
Ireland	Porcupine	35	8-2	3996
Ireland	Celtic	49	9-4	
Ireland	Celtic	49	9-4	1771
Ireland	Celtic	50	6-1	1610
Ireland	Celtic	50	6-1	
Norway	S. Viking Graben	Sleipner Alpha	15/9-1	3655
Norway	S. Viking Graben	Lille Frigg	25/2-12	3692
Norway	S. Viking Graben	E. Frigg Satellite	25/2-13	3695
Norway	S. Viking Graben	Vale	25/4-6S	3802
Norway	S. Viking Graben	Froy	25/5-1	2687
Norway	S. Viking Graben	Balder	25/11-5	
Norway	S. Viking Graben	Balder Satellite	25/11-16	
Ireland	Fasnet		CS 63/10-1	
UK	East Shetland	Cormorant (211)		
UK	Central Graben	Argyll (30)		
UK	East Shetland	Hutton (211)		
Canada	Newfoundland	Hibernia		2431-2440m
Netherlands	Southern North Sea	K18	1	
UK	Central Graben	(30)	14-1	2958
UK	Moray Firth	Ettrick	20/2-1	3236
UK	Moray Firth	Buchan	21/1-B1	2583
Norway	East Shetland	Snorre	N34/7-6	
UK	West Shetland	Clair (206)	7 #1	1633
UK	West Shetland	Clair (206)	9 #2	1724
UK	Inner Moray Firth	Beatrice (11-30B)		
Norway	N. Viking Graben	Oseberg	30/6	
UK	Irish Sea	Douglas	110/13-1	914
Russia	West Siberia	Aipim	5	2837
Russia	West Siberia	Soromin	6	2595
Russia	West Siberia	Vat'egan	4	2763
UK	S. Viking Graben	Bruce	9/9B-3	3845
UK	S. Viking Graben	Forth	9/23B-7	
UK	S. Viking Graben		9/23B-8	
USA	Baltimore Canyon	Wildcat	#642-2	